DIVERSITY OF APOIDEA AND DIPTERA IN UiTM PAHANG

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Abstract

Apoidea and some species of Diptera play a crucial role in the pollination of plants, honey production and also important in the biological control of agricultural pests. However, due to habitat destruction and lack of knowledge on the importance of bees and flies to human have caused these populations to dwindle. Absence of pollinator agents can lead to significant yield decline and eventually increasing food prices. This study aims to determine and to compare the diversity and the abundance of Apoidea and Diptera in UiTM Pahang. Bees and flies were caught in four different areas using sweep net and bottle traps filled with pheromones. The samples were then sorted, preserved, mounted, dried and identified. Two families of Apoidea (Apidae and Halictidae) and three families of Diptera (Tephritidae, Sarcophagidae and Syrphidae) were found. Fruit plantation has the highest diversity of Apoidea (H = 0.76) while agrotechnology site has the highest diversity of Diptera (H = 0.26). The result obtained was influenced by human activities, weather, captured time and method used. Future studies should focus on proper trap used based on different taxa, enlarging sampling site and extending sample collection time for a more accurate result. The role of Apoidea and Diptera as pollinators for economic contribution should be the main reason to conserve these species and adequately manage their habitat in the future.

Keyword: Apoidea, Diptera, evenness, pollinator, species diversity.

Introduction

Insects are the most abundant animals on earth, and they are widely found in various terrestrial as well as aquatic ecosystems. They evolve with their environment to survive and to reproduce, ensuring their genetic variations to remain for future generations as their adaptations are happening through the emergence of new features (Kamut & Jeziersky, 2014). The insects are the simplest invertebrates with wings, and because of that, they can leave a habitat when it becomes incompatible and find another habitat that is more convenient for their survival (Ibrahim, 2010).

Insects belong to the Phylum Arthropoda, Subphylum Hexapoda and Class Insecta. They can be determined by having three main body parts which are one pair of antennae, three pairs of jointed legs, and head, thorax and abdomen (Borror et al., 1989). Apoidea of Order Hymenoptera consists of bees and Order Diptera consists of flies. Apoidea features wasp-waist form from the secure attachment of the first abdominal segment to the thorax and firm constriction between dual abdominal segments (Sharkey, 2007). Dipterans have only one pair of wings as the hind wings are reduced and modified to a pair of specialised organs called halters that serve to maintain equilibrium during a flight (Trigunayat, 2009).

According to Bourke (2005), sociality is the factor that helps insects to survive and to continue their mutual relationship with human. Insects may cause harm to agricultural system or contrarily vital for agricultural production by acting as pollinators for crop plants. For example, most blood-sucking and scavenging Dipterans such as horse fly, black fly, stable fly, blowfly and housefly are vectors of diseases, while apple maggot and Hessian fly are critical pests of cultivated vegetation. However, many flies are also crucial parasites or predators of numerous insect pests, while others help with pollination of beneficial plants and enemies to harmful weeds. Examples of plants pollinated by flies are apples, onions, mango, cauliflower, carrot, mustard, cacao, tea and strawberry (Frimpong et al., 2011).

Hymenopterans such as Apoidea involve towards direct economic importance in the biological control of forestry pests, the pollination of angiosperms and the production of commercial products such as honey and beeswax (LaSalle & Gauld, 1993). Diversity of Hymenoptera is correlated with the diversity of other organisms due to its characteristics as keystone mutualist. It is well known that reduction in bee diversity is highly correlated with reduced flowering plant species because the bees play an essential role in fertilisation and reproduction of the flowering plant. For instance, some orchids that prefer specific bee pollinator for their fertilisation to occur will lose the ability to perform its specialised pollination system if the bee's presence is none. Young bee foragers can act as active pollinators and the old ones continue to gather nectar (Didham et al., 1996). A study by Woodcock et al., (2013) found that visitation of oilseed rape flowers by bees and eventually, the pollination of the flowers has contributed to the elevation of the crops yield.

Angiosperms play crucial roles in many agricultural ecosystems, producing fibre, food and shelter for wildlife and humankind alike. Moreover, there may be developing interest within the use of plants as gasoline resources (Calderone, 2012). Pollination is a vital step in the reproductive system of flowering plants because it is also required for the manufacturing of seeds. Pollination can occur from the action of abiotic forces which includes water and wind. However, eighty percent pollination of the angiosperms depends on animals, including flies, bats, beetles, butterflies, and other insects (Klein et al., 2007).

In recent years, the declining of crops' yields may be related to the abundance and the diversity of pollinating agents that are lessening in the growing areas. Due to the lack of exposure on the importance of Apoidea and Diptera to economy, ecology and survival of humankind, people tend to eradicate these species. Many Apoidea is considered a nuisance and some beneficial Dipterans are incorrectly identified as pests. The well-developed farm has proven the failure in pollination causes the decline in wild plant reproduction which is caused by either a limited number of pollinators or lack of mates (Samnegård et al., 2011).

This study was conducted to determine the abundance and the diversity of superfamily Apoidea of order Hymenoptera, and order Diptera at different localities in UiTM Pahang. This provides an opportunity for researchers and the public to identify Apoidea and Diptera species found in Malaysia and particularly in UiTM Pahang, Jengka Campus and also gives some value-added information on the ecosystem of this campus by producing an inventory of the species found here.

Materials and Methods

Sampling Areas and Methods

Insect samplings involved four areas in UiTM Pahang Jengka Campus namely Unit Ladang's fruit plantation, Taman Herba, the small garden next to the Bahagian Pembangunan dan Pengurusan Fasiliti (BPPF) building and the plantation area of Laman Agroteknologi. The area of each sampling site was not determined as the insects were moving around freely from one area to another. The bees and flies were caught in both fruit plantation and BPPF. However, the bees were only captured in Taman Herba, and the flies were only caught in Laman Agroteknologi. Sweep nets were used to catch bees, whereas for flies, most captures were done using plastic bottles filled with sex pheromones as baits. Sweep nets were used every morning and evening for 14 days and the baits were placed at the sampling sites and checked for trapped insects every day. Each successful catch was then placed in a small glass bottle filled with 70% ethanol solution to immediately kill and preserve the specimens.

Sample Preservation and Identification

Back in the lab, samples were sorted according to their physical characteristics. Then the insects were pinned on mounting boards. The pins used varied in size according to the size of the insects to minimise the damage of the insect bodies. For Apoidea, the pin must pass the bases of the forewing, just to the right from the middle. Insect wings were opened wide and held with the pin to see the number of flaps owned and patterns on the wings to aid in identification. For Diptera, the pin was pushed through the thorax to the right of the middle line (Trigunayat, 2009). After mounting, the specimens were dried in an oven at 30°C for three days or until completely dried. Then, they were stored in boxes filled with silica gel to minimise humidity that might cause the growth of fungi on the specimens.

The process of identification was done by referring and comparing the specimens to the extensive insect collections in Centre of Insect Systematics (CIS), Universiti Kebangsaan Malaysia (UKM), Bangi. Stereomicroscopes were used to recognise the unique features of the specimens and the insects were identified until the family level. The Shannon-Weiner Diversity Index, Evenness and Margalef Richness Index were calculated for each sampling sites.

Result and Discussion

A total of 1500 individuals were caught during the sampling period in the study sites. 87 individuals (5.8%) were Apoideans while 1413 individuals (94.2%) were Dipterans. Overall, two families of Apoidea (Apidae and Halictidae) and three families of Diptera (Tephritidae, Sarcophagidae and Syrphidae) were found. **Table 1** shows the percentages of individuals caught in the sampling sites. The large discrepancy on the number of captures between groups could be due to the traps used. Most Apoideans were caught using sweep net, and they were not attracted to the pheromone traps. According to Larsen et al. (2014), targeted insects of different taxa should be treated with different methods as they had differences in ecological drift and behavioural respond. Large number of Dipterans were caught using the hormone traps during sampling periods. However, the traps mostly captured male Dipterans compared to females. Many factors could contribute a low number of families captured, for example, disturbances such as pollution, agriculture and erosion, and also local rarity of some species (Larsen et al., 2014).

A dominant part of Apoidea found in UiTM Pahang were mostly black or brown with no mark in their body. However, members of Halictidae were quite distinctive from Apidae as they have blue markings on the body and hairy head. All Apoidea have hairy legs to carry pollen. Most Diptera found in the study sites were rather small and soft-bodied. They possessed one pair of wings which were small and transparent with simple venation. The head was large, connected to the thorax by a slender neck. The most distinctive feature was the large compound eyes on the surface of the head.

Table 1 Percentages of the abundance of Apoidea and Diptera in study sites

Family	Area				Total (%)
	Fruit Plantation (%)	BPPF (%)	Taman Herba (%)	Laman Agroteknologi (%)	
Apidae (A)	39.08	37.93	19.54	-	96.55
Halictidae (A)	2.3	1.15	0	-	3.45

Tephritidae (Di)	84.71	10.05	-	3.54	98.3
Sarcophagidae (Di)	0.57	0.71	-	0.28	1.56
Syrphidae (Di)	0.14	0	-	0	0.14

A: Apoidea; Di: Diptera
The percentages were calculated separately between superfamily Apoidea and order Diptera.

Apoidea was mostly found in the fruit plantation (41.38%) and the garden beside BPPF (39.08%), whereas Diptera was mostly found in the fruit plantation (85.42%). During the sampling period, most of the plants in the study sites were in varying degrees of flowering or fruiting stages. This finding is consistent with the studies conducted by Cutler et al. (2015), where high abundance of Apoidea was found during blooming periods. Depending on bee species, bees needed about seven to 1100 flowers to obtain highly nutritious pollen and nectar, and the pollens that are available for female bee to make one larva is 40% from each single flower (Müller et al., 2006), explaining why bees are abundant when host plants are in flowering periods. In the case of BPPF, most Apoidea was found on citrus trees and this could be because the plants produce a strong scent that attracted the bees.

A type of fruit flies from genus *Bactrocera* of family Tephritidae was found to be abundant in the fruit plantation. Members of Tephritidae are attracted to various flowering trees in the plantation such as sapodilla, rambutan and guava. The second most abundant of Diptera was Sarcophagidae (10.76%) or flesh flies. Although the members of this family are considered scavengers, they can also act as pollinators as they continuously visit flowers and transmit pollens on their legs (Kaczorowska, 2009). Members of Syrphidae are pollinators, but they were the least caught in all the study sites even though the flowers were blooming. According to Souza-Silva et al. (2001), Syrphidae is abundant when other pollinating families in an area are rare or absent. The low number of Syrphidae caught could also be due to the traps that were not suitable to catch Syrphidae flies. A high number of captures in fruit plantation for all families could be due to the large sampling area of the plantation compared to other sites.

Shannon-Weiner Diversity Index (H’) is used to measure diversity in a community where it incorporates the abundance and the species richness in the community. Evenness Index (E) is used to measure dominance of species or how even a community in terms of abundance, and Margalef Richness Index (D) is used to measure species richness, the number of various species present in an area (Gotelli and Chao, 2013). Based on **Table 2**, fruit plantation has the highest H’ (0.75), E (0.55) and D (0.78) values for Apoidea. For Diptera, Laman Agroteknologi has the highest H’ (0.26) and E (0.38) values, but the fruit plantation has the highest D (0.28) values.

Table 2 Diversity indices at the study sites

Indices	**Area**			
	Fruit Plantation	**BPPF**	**Taman Herba**	**Laman Agroteknologi**
H' (A)	0.76	0.46	0.34	-
H' (Di)	0.05	0.24	-	0.26
E (A)	0.55	0.42	0.49	-
E (Di)	0.05	0.35	-	0.38
D (A)	0.78	0.55	0.34	-

D (Di)	0.28	0.2	-	0.25

H': Shannon-Weiner Diversity Index; E: Evenness Index; D: Margalef Richness Index; A: Apoidea; Di: Diptera

The indices were calculated separately between superfamily Apoidea and order Diptera.

According to Magurran (2004), if a H' value is between 1.5 and 3.5, it indicates the site has moderate species diversity. Based on **Table 2**, all study sites regardless of taxa have H' values below than 1.5. It means that all of the study sites have low diversity of Apoidea and Diptera. Species diversity could indicate the complexity of an environment. Typically, high species diversity can be obtained from undisturbed habitats such as primary rainforest (Magurran, 2013). Although the vegetations in all study sites were somewhat mixed, they were considered as highly disturbed and the habitat structures were not contributing to the low H' values. Regarding evenness of communities, no study sites were completely uniform as all the E values are below 1.00 (complete homogenous).

Conclusion

A total of 87 individuals of Apoidea and 1413 individuals were recorded during the fourteen days study periods; two families of superfamily Apoidea which were Apidae (96.55%) and Halictidae (3.45%), and three families of order Diptera which were Tephritidae (98.3%), Sarcophagidae (1.56%) and Syrphidae (0.14%). Fruit plantation recorded the highest diversity index for Apoidea (H'=076) whereas Laman Agroteknologi recorded the highest for Diptera (H'=0.26). All of the diversity index for all families in all sampling sites were considered as low. The traps used were not effective in catching Apoidea, and the traps might be biased towards Tepthritidae. So, for future studies, tent-like malaise traps are recommended to be used in trapping Apoidea and Diptera. Comparison studies on different seasons (dry vs rainy) should be done to determine the effects of different abiotic factors on the abundance and the distribution. Period and area of sampling should also be extended to get more reliable data.

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Conflict of Interests

Authors hereby declare that there is no conflict of interests.

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